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(19)

(54) IMPROVEMENTS IN AND RELATING TO LUMINESCENT MATERIALS

(71) We, JOHNSON, MATTHEY & CO., LIMITED, a British Company, of 43 Hatton Garden, London, EC1 8EE, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to luminescent materials, especially to such materials which may be used in cathode-ray tubes in which a high-brightness display is required, for example, in the cockpit of an aircraft.

Luminescent materials, often known as "phosphors" or "phosphor materials", are chemical compounds which, as a result of stimulation or excitation by electromagnetic radiation of a certain wavelength, or by a beam of cathode rays, emit radiation typically in the visible region of the spectrum, because the human eye is phosphor determines its absorption and emission characteristics and other properties, such as its brightness and its efficiency, by which is meant the amount of light emitted relative to the amount of excitation radiation.

It is desirable for a cathode ray tube for use in an aircraft cockpit, for example, to be coated with a phosphor which emits light predominantly in the green region of the spectrum, because othe human eye is particularly sensitive to radiation falling within this wavelength band. Furthermore, it is desirable that the phosphor is capable of emitting light having a high brightness. This may be accomplished by using high-energy excitation radiation, but a disadvantage of phosphors used up to now—such as Zn_2SiO_4:Mn, known internationally as "P1" phosphor—is that, under such high-excitation conditions, they tend to have a limited useful life due to degradation and burning.

Accordingly, it is an object of the present invention to provide a novel phosphor composition which does not suffer, under high excitation conditions, from the disadvantages referred to above and which is otherwise suitable for coating the screen of a cathode ray tube for use in, for example, an aircraft cockpit.

According to the invention, a luminescent material comprises an aluminium garnet host material including gallium and/or scandium and activated with trivalent terbium, and optionally co-activated with trivalent cerium, and having a composition according to the formula $RE_{(3-x)}A_xAl_{(5-(y+z))}Sc_yGa_zO_{12}$ in which RE is one or more of the elements yttrium, gadolinium and lutetium, A is either Tb or (Tb+Ce), $0.01 \leq x \leq 0.5$, $0 \leq y \leq 2$, $0 \leq z < 5$ and $1 \leq (y+z) < 5$.

One particular phosphor according to the invention has the formula $Y_{3-x}Al_4ScO_{12}:Tb_x$. This phosphor has enhanced resistance to degradation and burning under high-excitation conditions compared with prior art phosphors.

Another phosphor according to the invention has the formula $Y_{2.9}Tb_{0.05}Ce_{0.01}Al_4GaO_{12}$. This phosphor has enhanced brightness compared with a phosphor without the Ce.

Phosphors according to the invention may be prepared by any of the methods well-known in the art. For example, and by preference, they may be prepared by the co-precipitation technique as described in the accompanying Example.

Example

5.241 of yttrium oxide, 0.268 g of terbium oxide and 1.650 of scandium oxide are dissolved in about 30 ml. of moderately concentrated nitric acid. The solution is combined with a solution of aluminium nitrate containing 1.506 g of aluminium. This combined solution is added slowly to about 500 ml of water which is stirred continuously, while simultaneously adding dilute ammonium hydroxide solution sufficient to maintain the reactant mixture at a pH of about 8. When the resultant precipitation is complete, the precipitate is

allowed to digest and is then filtered off, washed and oven dried. After crushing to a uniform powder, this is fired at 700°C in air for about 1 hour, crushed again and refired at 1550°C in air for about 16 hours to give a phosphor according to the invention with a composition of $Y_{2.91}Tb_{0.09}Sc_{1.5}Al_{3.5}O_{12}$.

WHAT WE CLAIM IS:—

1. A luminescent material comprising an aluminium garnet host material including gallium and/or scandium and activated with trivalent terbium, and optionally co-activated with trivalent cerium, and having a composition according to the formula $RE_{(3-x)}A_xAl_{(5-(y-z))}Sc_yGa_zO_{12}$ in which RE is one or more of the elements yttrium, gadolinium and lutetium. A is either Tb or (Tb+Ce), $0.01 \leq x \leq 0.5$, $0 \leq y \leq 2$, $0 \leq z < 5$ and $1 \leq (y+z) < 5$.

2. A material according to claim 1 having the formula $Y_{3-x}ScAl_4O_{12}:Tb_x$.

3. A material according to claim 1 having the formula $Y_{2.9}Tb_{0.09}Ce_{0.01}GaAl_4O_{12}$.

4. A material according to claim 1 having the formula $Y_{2.91}Tb_{0.09}Sc_{1.5}Al_{3.5}O_{12}$.

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